Appl. No.: 09/872,205
Amdt. dated: September 20, 2004
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7146.0113

This listing of claims filed October 20, 2004 will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1(original). A method of image processing comprising the steps of:

(a) determining a probability that an input pixel is one of a background and a foreground pixel of said image by comparing said input pixel to a background reference pixel model; and

(b) revising said probability for said input pixel according to a probability that a neighboring pixel is a pixel of one of said background and said foreground and a relationship of said input pixel and a pixel structure included in said image.

2(original). The method of claim 1 wherein the step of determining a probability that an input pixel is one of a background and a foreground pixel of said image by comparing said input pixel to a model of a background reference pixel comprises the steps of:

(a) comparing a difference between said input pixel and said background reference pixel model to a threshold difference;

(b) determining said probability that said input pixel is one of said background and said foreground pixels from a first probability function if said difference at least equals said threshold difference; and

(c) determining said probability that said input pixel is one of said background and said foreground pixels from a second probability function if said difference does not at least equal said threshold difference.

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3(original). The method of claim 2 wherein said difference between said input pixel and said background reference pixel model comprises a difference in a chromatic value of said input pixel and said background reference pixel model.

4(original). The method of claim 2 wherein said threshold comprises a chromatic value.

5(original). The method of claim 1 wherein the step of revising said probability for said input pixel according to a probability that a neighboring pixel is a pixel of one of said background and said foreground and a relationship of said input pixel and a pixel structure included in said image comprises the steps of:

    (a)   filtering said image to identify a pixel structure included in said image;

    (b)   assigning a first probability that a pixel neighboring said input pixel is a pixel of one of said background and said foreground as said revised probability for said input pixel, if said input pixel is included in said structure; and

    (c)   if said input pixel is not included in said structure, assigning a second probability that a pixel neighboring said input pixel is a pixel of one of said background and said foreground as said revised probability for said input pixel.

6(original). The method of claim 1 wherein said background reference pixel model is a mean of a pixel of a background reference image and at least one input pixel of an image background.

7(original). The method of claim 1 further comprising the step of revising said background reference pixel model if said input pixel is a pixel of said background.

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8(original). The method of claim 1 further comprising the step of substituting a new pixel for said input pixel in said image if said revised probability determines that said input pixel is more probably a pixel of said background.

9(canceled). A method of segmenting an image, said method comprising the steps of:

    (a) capturing said image comprising a plurality of input pixels representing a background and a foreground of a scene;

    (b) capturing a background reference image comprising a plurality of background reference pixels representing said background of said scene;

    (c) classifying an input pixel as one a pixel of said background and said foreground according to a relationship of said input pixel to a background reference pixel;

    (d) identifying a structure in said input image; and

    (e) revising said classification of said input pixel according to a membership of said input pixel in said structure.

10(canceled). The method claim 9 wherein the step of classifying an input pixel as one of a background and a foreground pixel according to a relationship of said input pixel to a background reference pixel comprises the steps of:

    (a) determining a first probability that said input pixel is a pixel of one of said background and said foreground if a relationship of said input pixel and said background reference pixel at least equals a threshold; and

    (b) determining a second probability that said input pixel is a pixel of one of said background and said foreground if said relationship of said input pixel and said background reference pixel does not at least equal to said threshold.

11(canceled). The method of claim 10 wherein at least one of said first and said second probabilities is a function of a difference between said input pixel and said background reference pixel.

12(canceled). The method of claim 11 wherein said difference between said input pixel and said background reference pixel comprises a difference between a chromatic value of said input pixel and a chromatic value of said background reference pixel.

13(canceled). The method of claim 12 wherein at least one of said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components of said pixel.

14(canceled). The method of claim 10 wherein said relationship of said input pixel and said background reference pixel comprises a difference between a chromatic value of said input pixel and a chromatic value of said background reference pixel.

15(canceled). The method of claim 14 wherein at least of one said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components of said pixel.

16(canceled). The method of claim 14 wherein said chromatic value of said background reference pixel comprises a mean of a plurality of chromatic values for a plurality of background pixels included in a plurality of images.

17(canceled). The method of claim 10 wherein said threshold comprises a function of a chromatic value for said background reference pixel.

18(canceled). The method of claim 17 wherein said function of said chromatic value of said background reference pixel comprises a function of a standard deviation of a chromatic value of a plurality of background pixels included in a plurality of images.

19(canceled). vThe method of claim 9 wherein the step of identifying a structure in said image comprises the step of filtering said image with a morphological filter to identify a plurality of connected input pixels in said image.

20(canceled). The method of claim 9 wherein the step of revising said classification of said input pixel according to a membership of said input pixel in said structure comprises the steps of:

    (a) revising one of said first and said second probabilities according to a first relationship if said input pixel is a pixel included in said structure; and

    (b) revising one of said first and said second probabilities according to a second relationship if said input pixel is not a pixel included in said structure.

21(canceled). The method of claim 20 wherein at least one of said first and said second relationships comprises a probability that a pixel neighboring said input pixel is a pixel of one of said background and said foreground.

22(canceled). The method of claim 20 wherein said first relationship comprises a minimum probability that one of a plurality of pixels neighboring said input pixel is a background pixel.

23(canceled). The method of claim 20 wherein said second relationship comprises a
maximum probability that one of a plurality of pixels neighboring said input pixel is
a background pixel.

24(canceled). The method of claim 9 further comprising the step of revising a
background reference pixel according to a relationship of said background
reference pixel and an input pixel.

25(canceled). The method of claim 24 wherein the step of revising said background
reference pixel according to a relationship of said background reference pixel and
an input pixel comprises the step of determining a mean of a chromatic value of
said background reference pixel and a chromatic value of said input pixel if said
input pixel is classified as a pixel of said background.

26(canceled). A method of segmenting an image comprising the steps of:

   (a) capturing said image comprising a plurality of input pixels representing a
   background and a foreground of a scene;

   (b) capturing a background reference image comprising a plurality of
   background reference pixels representing a background of said scene;

   (c) determining a probability that an input pixel is a pixel of one of said
   background and said foreground according to a relationship of a value
   measuring said input pixel and a value measuring a background
   reference pixel;

   (d) identifying a pixel structure in said image;

   (f) revising said probability for said input pixel according to a membership of
   said input pixel in said pixel structure and a probability that a neighboring
   pixel is a pixel of one of said background and said foreground; and

(g) revising said value measuring said a background reference pixel
according to a relationship of said background reference pixel and said
input pixel.

27(canceled). The method claim 26 wherein the step of determining a probability that
an input pixel is a pixel of one said background and said foreground according to a
relationship of a value measuring said input pixel and a value measuring a
background reference pixel comprises the steps of:

(a) determining a first probability that said input pixel is a pixel of one of said
background and said foreground if a relationship of said values measuring
said input pixel and said background reference pixel at least equals a
threshold; and

(b) determining a second probability that said input pixel is a pixel of one of
said background and said foreground if said relationship of said values
measuring said input pixel and said background reference pixel does not
at least equal to said threshold.

28(canceled). The method of claim 27 wherein at least one of said first and said
second probabilities is a function of a difference between said values measuring
said input pixel and said background reference pixel.

29(canceled). The method of claim 28 wherein said difference between said values
measuring said input pixel and said background reference pixel comprises a
difference between a chromatic value of said input pixel and a chromatic value of
said background reference pixel.

30(canceled). The method of claim 29 wherein at least of one said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components for said pixel.

31(canceled). The method of claim 27 wherein said relationship of said values measuring said input pixel and said background reference pixel comprises a difference between a chromatic value of said input pixel and a chromatic value of said background reference pixel.

32(canceled). The method of claim 31 wherein at least one said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components for said pixel.

33(canceled). The method of claim 31 wherein said chromatic value of said background reference pixel comprises a mean of a chromatic value for a plurality of background pixels included in a plurality of images.

34(canceled). The method of claim 27 wherein said threshold comprises a relationship for a chromatic value for said background reference pixel.

35(canceled). The method of claim 24 wherein said relationship for said chromatic value of said background reference pixel comprises a function of a standard deviation of a chromatic value for a plurality of background pixels included in a plurality of images.

36(canceled). The method of claim 26 wherein the step of identifying a pixel structure
in said image comprises the step of filtering said image with a morphological filter
to identify a plurality of connected input pixels in said image.

37(canceled). The method of claim 26 wherein the step of revising said probability for
said input pixel according to a membership of said input pixel in said pixel structure
and a probability that a neighboring pixel is a pixel of one of said background and
said foreground comprises the steps of:

(a) assigning a first probability value to said input pixel if said input pixel is a
pixel included in said structure; and

(b) assigning a second probability value to said input pixel if said input pixel
is not a pixel included in said structure.

38(canceled). The method of claim 37 wherein at least one of said first and said
second probability values comprises a probability that one of a plurality of
neighboring pixels is a pixel of one of said foreground and said background.

39(canceled). The method of claim 37 wherein at least one of said first and said
second probability values comprises one of a minimum and a maximum
probability that one of a plurality of neighboring pixels a pixel of one of said
foreground and said background.

40(canceled). The method of claim 26 wherein the step of revising said value
measuring said a background reference pixel according to a relationship of said
background reference pixel and said input pixel comprises the step of determining
a mean of said value measuring said background reference pixel and said value
measuring said input pixel if said input pixel is a pixel of said background.

41(canceled). The method of claim 40 wherein at least one of said values measuring
said input pixel and said background reference pixel comprises a chromatic value
for said pixel.

42(canceled). The method of claim 41 wherein at least one said chromatic value of
said input pixel and said background reference pixel comprises a sum of a plurality
of chromatic components for said pixel.

43(original). A method of processing an image comprising the steps of:

    (a) capturing an image comprising a plurality of input pixels representing a
background and a foreground of a scene;

    (b) capturing a background reference image comprising a plurality of
background reference pixels representing a background of said scene;

    (c) determining a probability that an input pixel is a pixel of one of said
background and said foreground according to a relationship of said input
pixel and a background reference pixel;

    (d) identifying a pixel structure in said image;

    (f) revising said probability for said input pixel according to a membership of
said input pixel in said pixel structure and a probability that a neighboring
pixel is a pixel of one of said background and said foreground; and

    (g) substituting a new background pixel for a spatially corresponding input
pixel classified as a background pixel.

44(original). The method claim 43 wherein the step of determining a probability that an
input pixel is a pixel of one of said background and said foreground according to a
relationship of said input pixel and a background reference pixel comprises the
steps of:

(a) determining a first probability that said input pixel is a pixel of one of said background and said foreground if a relationship of said input pixel and said background reference pixel at least equals a threshold; and

(b) determining a second probability that said input pixel is a pixel of one of said background and said foreground if said relationship of said input pixel and said background reference pixel does not at least equal to said threshold.

45(original). The method of claim 44 wherein at least one of said first and said second probabilities is a function of a difference between said input pixel and said background reference pixel.

46(original). The method of claim 45 wherein said difference between said input pixel and said background reference pixel comprises a difference between a chromatic value of said input pixel and a chromatic value of said background reference pixel.

47(original). The method of claim 46 wherein at least one of said functions of said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components for said pixel.

48(original). The method of claim 44 wherein said relationship of said input pixel and said background reference pixel comprises a difference between a chromatic value of said input pixel and a chromatic value of said background reference pixel.

49(original). The method of claim 48 wherein at least one said chromatic values of said input pixel and said background reference pixel comprises a sum of a plurality of chromatic components for said pixel.

50(original). The method of claim 48 wherein said chromatic value of said background reference pixel comprises a mean of a plurality of chromatic values for a plurality of background pixels included in a plurality of images.

51(original). The method of claim 44 wherein said threshold comprises a function of a chromatic value for said background reference pixel.

52(original). The method of claim 51 wherein said function of said chromatic value of said background reference pixel comprises a function of a standard deviation of a chromatic value for a plurality of background pixels included in a plurality of images.

53(original). The method of claim 43 wherein the step of identifying a structure in said image comprises the step of filtering said image with a morphological filter to identify a plurality of connected input pixels in said image.

54(original). The method of claim 43 wherein the step of revising said probability for said input pixel according to a membership of said input pixel in said pixel structure and a probability that a neighboring pixel is a pixel of one of said background and said foreground comprises the steps of:

    (a) revising one of said first and said second probabilities according to a first relationship if said input pixel is a pixel included in said structure; and

    (b) revising one of said first and said second probabilities according to a second relationship if said input pixel is not a pixel included in said structure.

55(original). The method of claim 54 wherein at least one of said first and said second relationships comprises a probability that a pixel neighboring said input pixel is a pixel of one of said background and said foreground.

56(original). The method of claim 54 wherein at least one of said first and said second relationship comprises one of a maximum and a minimum of a probability that a pixel neighboring said input pixel is a pixel of one of said foreground and said background.

57(original). The method of claim 43 further comprising the step of revising a background reference pixel according to a relationship of said background reference pixel and an input pixel.

58(original). The method of claim 57 wherein the step of revising said background reference pixel according to a relationship of said background reference pixel and an input pixel comprises the step of determining a mean of a chromatic value of said background reference pixel and a chromatic value of said input pixel if said input pixel is classified as a pixel of said background.

59(original). A method of replacing an image background in a video sequence comprising the steps of:
  (a) capturing an image comprising a plurality of input pixels representing a background and a foreground of a scene;
  (b) capturing a background reference image comprising a plurality of background reference pixels representing a background of said scene;

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(c) classifying an input pixel as a pixel of said background if a difference between said input pixel and a background reference pixel is less than a threshold difference;

(d) filtering said image to identify a pixel structure included in said image;

(e) revising said classification of said input pixel according to a first probability relationship if said input pixel is a pixel of said pixel structure;

(f) revising said classification of said input pixel according to a second probability relationship if said input pixel is not a pixel of said pixel structure;

(g) revising a background reference pixel if said revised classification of a spatially corresponding input pixel classifies said input pixel as a background pixel;

(h) substituting a new background pixel for said input pixel if said input pixel is classified as a pixel of said background; and

(i) capturing another image comprising a plurality of input pixels representing a background and a foreground of said scene.

60(original). The method of claim 59 wherein the step of classifying an input pixel as a pixel of said background if a difference between said input pixel and a background reference pixel is less than a threshold difference comprises the steps of:

(a) determining a difference between a chromatic value for said input pixel and a chromatic value for said background reference pixel; and

(b) comparing said difference to a threshold chromatic value.

61(original). The method of claim 60 wherein at least one of said chromatic values of said input pixel, said background reference pixel and said threshold comprises a sum of a plurality of chromatic components.

62(original). The method of claim 60 wherein said threshold is a function of a standard deviation of a chromatic value of said background reference pixel.

63(original). The method of claim 60 wherein said chromatic value of said background reference pixel comprises a mean of a chromatic value of a plurality of background pixels from a plurality images.

64(original). The method of claim 59 wherein the step of revising said classification of said input pixel according to a first probability relationship if said input pixel is a pixel of said pixel structure comprises the step of assigning to said input pixel a probability that one of a plurality of neighboring pixels is a background pixel if said input pixel is a pixel of said structure.

65(original). The method of claim 59 wherein the step of revising said classification of said input pixel according to a second probability relationship if said input pixel is a pixel of said pixel structure comprises the step of assigning to said input pixel a probability that one of a plurality of neighboring pixels is a background pixel if said input pixel is a pixel of said structure.

66(original). The method of claim 59 wherein the step of revising a background reference pixel if said revised classification of a spatially corresponding input pixel classifies said input pixel as a background pixel comprises the step of calculating the mean of a chromatic value of said background reference pixel and said spatially corresponding input pixel of said background.